ROCKY FLATS PLANT, GENERAL MANUFACTURING,
SUPPORT, RECORDS/CENTRAL COMPUTING
(Plant B) (Building 881)
Southern portion of the Plant
Golden vicinity
Jefferson County
Colorado

HAER No. CO-83-Q

HAER
COLO
30-GOLD.V,
1Q-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
1849 C St. NW
Washington, DC 20240

HAER
COLO
30-GOLD.V
1Q-

HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
MANUFACTURING AND
GENERAL SUPPORT
(Rocky Flats Plant, Building 881)
(Rocky Flats Plant, Plant B)

HAER No. CO-83-Q

Location: Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. The facility is located in the southern portion of the Rocky Flats Plant (Plant).

Date of Construction: 1951.

Fabricator: Austin Company, Cleveland, Ohio.

Present Owner: United States Department of Energy (USDOE).

Present Use: Administrative Operations.

Significance: This building is a primary contributor to the Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Initially known as Plant B, Building 881 was one of the four original manufacturing buildings that comprised the Plant in the early 1950s and was the fourth building to become operational. Beginning in 1953, this structure housed the Plant's only enriched uranium component manufacturing and recovery operations. A large part of the early work at the Plant took place in this building, because the triggers required a large amount of enriched uranium.

Historians: D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e^2M), 1997. Judith Berryman, Ph.D., Archaeologist, e^2M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado

State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Rocky Flats Plant is one of thirteen USDOE facilities that constitute the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained nuclear weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. Each trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were staged on submarines, bombers, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads, known as theater weapons, used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf-life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex: manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 881:

1951	Construction began.
1952	Plant operations began.
1953	Enriched uranium operations began; original building contained a foundry, analytical laboratory, machine shop, steam plant, and laundry.
1955	An L-shaped annex was added to the northeast corner of Building 881 for a machining facility.
1957	A reinforced concrete tunnel was constructed to transport enriched uranium between Buildings 883 and 881.
1964	Enriched uranium activities were phased out between 1964 and 1966. Enriched uranium recovery operations ended in 1964.
1966	Building operations shifted to other metals; stainless steel fabrication operations began.
1967	Beryllium sealing operations began; beryllium ingots received from Building 444 were placed into stainless steel cans that were sent on to be rolled in Building 883; J-line stainless steel activities began.
Mid-1970s	Uranium recovery operations on parts received from Oak Ridge Reservation were discontinued.
1984	Stainless steel machining moved to Building 460.
1991	Construction of new air filter plenum, Building 881F; the new plenums replaced two exhaust plenums located in the northeast corner of the first and second floors of Building 881.

Building History:

Initially known as Plant B, Building 881 was one of the four original manufacturing buildings that comprised the Plant in the early 1950s and was the fourth building to come on-line. Beginning in 1953, this structure housed the Plant's only enriched uranium component manufacturing and recovery operations. The original purpose of Building 881 was the processing and machining of enriched uranium (oralloy) into finished weapons components. The oralloy process included chemical recovery operations and foundry equipment. A large part of the early work at the Plant took place in this building, because the triggers required a large amount of enriched uranium.

Enriched uranium recovery processes used at the Plant were based upon those developed at the Los Alamos Scientific Laboratory and the Oak Ridge Reservation during and after World War II. The processes were refined at the Oak Ridge Reservation Y-12 Plant in the several years preceding the construction of the Rocky Flats Plant.

Plant personnel contributed many unique improvements to enriched uranium recovery processes. Improvements were made to the continuous dissolution processes of the following materials: sand and slag from foundry operations; and skull oxide (material recovered form foundry crucibles). Improvements were made in the other continuous processes for: peroxide precipitation; calcination of uranium peroxide; and leaching of powdered solids. Site personnel developed improved processes for graphite incineration; oralloy parts decontamination; and achieved a 15-kilogram (kg) scale reduction of uranium tetrafluoride to metal.

Equipment improvements included safe dimension troughs for continuous leaching or dissolution, safe-dimension rotary drum vacuum filters, and a continuous rotary calciner. Pyrex® glass Raschig rings were used extensively as the primary criticality control of large process vessels.

In 1964, enriched uranium operations in the building began to be phased out with the advent of the Atomic Energy Commission's single mission policy for each facility within the nuclear weapons complex. This policy was instituted to eliminate redundancy of activities within the complex. Production of oralloy components ceased at the Plant in 1964, when the Y-12 Plant at the Oak Ridge Reservation assumed sole responsibility.

Associated with this single mission policy was the transfer of stainless steel manufacturing from the American Car and Foundry Company of Albuquerque New Mexico to the Plant, Building 881. Stainless steel manufacturing, referred to as the J-line, began in 1966. These operations occupied the space that enriched uranium processes formerly occupied. Fabrication and testing of stainless steel parts was conducted in Building 881until 1984, when Building 460 was constructed.

Building Description:

Building 881 is an irregularly shaped, multiple-level structure that is built into the side of a hill. The main portion of Building 881 is underground, with the exception of Building 881F, a gabled-roof section that rises two stories. Overall elevations vary: at the northern end, the building roof is at ground level; at the southern end, the first floor is at ground level. At the southern end of the structure, the exterior walls of both stories are exposed. Areas east of the building are graded, allowing roadway access to the second floor loading dock and to the first floor on the south. Building 881 is considered to be a three-story structure with mezzanine levels on the first and second floors. The complex encompasses approximately 245,000 square feet: 86,300 on the first floor; 6,000 square feet on the first floor mezzanine; 121,460 square feet on the second floor; 13,530 square feet on the second floor mezzanine; and 17,870 square feet in the basement.

All exterior walls and foundations are reinforced concrete with continuous footings. The interior columns are concrete with spread footings. The primary structural framing of the building is poured-in-place reinforced concrete columns and beams. Structural steel beam framing is used in the center stairway and in the roof on the 881 Annex. All floors are reinforced concrete. The ground floor above the basement contains reinforced concrete, supported by concrete beams. The second floor consists of either flat or beam concrete slabs.

The interior walls are either reinforced concrete (elevators, stairwells, and some rooms), concrete block, metal studs covered with gypsum board, or brick. The majority of the ceilings are either concrete slab or insulated metal pan. A few of the ceilings are steel sheets or acoustical tile. Depending on location and function, a variety of doors are present in the structure, including hollow metal (some lined with lead), steel roll-up doors, vault doors, and doors with wire mesh panels. There are no outside windows in the building.

The roof for Building 881 is flat and flush with the finished grade along the north and most of the east and west walls. There are four exits onto the roof. The original roof construction has 1' of insulation covered with built-up roofing on top of a concrete roof slab.

A reinforced concrete radiography vault (28' x 38' x 12') is located in the northeastern portion of the second floor. Four concrete bell-type caissons support the weight of the vault.

The building contains several reinforced concrete tunnels that provide both interior and exterior access. In general, the tunnels are constructed with reinforced concrete slab floors (10" thick) with 9" thick walls. There are two east portal tunnels that provide access to and from the second floor of the building (which is underground). The northernmost of these two tunnels is L-shaped and measures 100' x 8.3' x 10'. Loading dock and truck areas are contained within the shorter section of this tunnel. The second tunnel measures 17' x 65' x 9'. A third concrete tunnel connects Building 883 to the second floor of 881, this tunnel is 192' long and 8' to 10' high. Additionally, there are four utility tunnels in the basement that are 4', 10', 15', and 18' wide, with an average height of 11'. These basement tunnels were designed as fallout shelters and used for storage.

Many of the rooms in the structure have been partitioned since initial operations. The first floor is divided into four general areas: administrative offices and the central computing facility in the southwest portion of the building; future systems group in the northwest portion; utility systems in the northeast portion; and analytical laboratories, maintenance shops, and offices in the southeast section. The first floor mezzanine contains offices for the future systems group, maintenance and records storage areas, general offices, and an instrument laboratory (Room 114J). The future systems group created illustrations, models, and engineering prototypes used for weapons and energy-related concepts.

Enriched uranium and stainless steel weapons component production-related activities occurred primarily on the second floor. The floors in most of the production areas are surfaced with stainless steel to contain spills and facilitate cleaning. The second floor contains a lunch/break room; locker rooms; research and instrument laboratories; a radiation monitoring support area; offices; locker rooms; storage vaults; an instrument library; production machining, joining, and assembly shops; and radiography vaults. The second floor mezzanine contains offices, air filter banks, inlet air plenums, a utility room, control systems, and a brazing laboratory.

The basement level contains some building utility support systems, including three boilers, process cooling water tanks, pumps, an emergency generator, and electrical equipment. Tunnels in the basement are used primarily for storage. A pit is also located in the basement area, and is accessed by the basement tunnels. The pit contains tall process equipment.

An L-shaped annex was added to the northeast portion of the original building in 1955. The annex was added to provide additional space for enriched uranium component manufacturing processes. Later, stainless steel manufacturing processes were housed in this area.

Building 881 Complex
Additional buildings that make up the Building 881 complex include: Building 830 (isolated power supply); Building 881F (filter plenum for Building 881); Building 881G (diesel generator); Building 881H (electrical interfaces); Building 864 (guard post); Building 882 (hydrogen gas cylinder storage); Building 885 (paint and oil storage); Building 887 (sanitary and process waste lift station); and Building 890 (cooling tower).

Building 830 is located east of Building 881. The building is sometimes used for storage of disposal materials and equipment. Building 881F, considered an integral part of Building 881, is a metal-siding-on-metal-frame building located on the roof of Building 881. Building 881F was placed in operation around 1991, replacing two exhaust plenums located in the northeast corner of the first and second floors of Building 881.

Building 881G is a prefabricated metal building located on the first-floor level of Building 881, immediately south of the Building 881 exterior wall. This structure houses a 400-kilowatt diesel generator. Building 881H, a prefabricated metal building located on the east side of Building 881, houses various switches, switchgear, breakers, and distribution panels needed to supply power to Building 881. Building 864 is a reinforced concrete, one-story guard post, located west of Building 881. Building 882, the hydrogen gas cylinder storage shed, is a steel-framed lean-to located east of Building 881. Building 885 is a single-room, single-story, prefabricated metal building located south of Building 881, which was used to store solvents, paints, thinners, and oils used in Building 881 processes.

Building 887 is a two-level reinforced concrete building used for handling sanitary and process waste products derived from Building 881 processes. Building 887 is located south of Building 881 and houses the appropriate pipes, sample points, and pumps to transfer process waste from Building 881 to the site process waste system. Building 890, the cooling tower, consists of three structures, a reinforced concrete basin, a prefabricated wooden cooling tower with wooden stairs, and a single-story pump house. Building 890 is located east of Building 881.

A high-pressure facility consisting of a chamber, a passageway, and a blast tunnel is located on the eastern side of the building. The high-pressure facility was used for testing purposes.

The entire Building 881 complex is enclosed in security fencing. Access is either through the Building 864 Guard Post, located west of the building, or through the Building 888 Guard Post off Central Avenue, to the northeast.

Building Operations:

Building 881 operations can be divided into three categories representing three distinct periods: enriched uranium manufacturing and recovery and special projects (1952-66); stainless steel operations (1966-84); and recent activities (post-1984).

Enriched Uranium Manufacturing and Recovery and Special Projects (1952-66)
Enriched uranium component manufacturing and recovery processes were housed in Building 881 from 1952 until 1964. Manufacturing and recovery operations were phased out at the Plant between 1964 and 1966. Limited enriched uranium recovery operations for site returns (weapons returned to the Plant for upgrade, reproccessing or retirement) continued at the Plant until the mid-1970s. After 1966, prefabricated enriched uranium components were shipped to the Plant from other USDOE facilities to be incorporated into the final trigger assembly.

Manufacturing
Enriched uranium component manufacturing included a foundry for casting of shapes and ingots and machining and inspection of enriched uranium components. Initially, hockey-puck-sized buttons of pure enriched uranium were received at the Plant from Oak Ridge Reservation in Tennessee. These buttons went directly to the machining operations to be shaped. A few months after Building 881 became operational, enriched uranium buttons were produced for the foundry when recovery operations in the building were brought on line.

The original foundry process cast enriched uranium into spherical shapes that were sent directly to machining operations. When the hollow core weapon design replaced the first trigger design, enriched uranium was cast into ingots from which components were fabricated (rolled, formed, and machined).

Casting operations began with two furnaces in Room 242. As production increased, four additional furnaces were added in Room 249. In the casting process, uranium metal was placed in a crucible, heated in bottom-pouring induction furnaces, and then poured into graphite molds to form spherical shapes (1952-57) or slabs and ingots (1957-64). Crucibles in the casting process were originally made of magnesium oxide, after 1958 they were made of graphite.

Between 1952 and 1957, cast spherical shapes went directly for final machining. Milling machines and lathes in Rooms 245 through 247 were used to form the final shape of the first trigger design. The new hollow core trigger design was more complex and required additional manufacturing steps. Enriched uranium was cast into slabs or ingots in Building 881, and was sent to Side B of Building 883 for rolling and forming, then returned to Building 881 for final machining. By 1957, computer-tape-controlled turning machines used in the final machining process provided additional precision needed for hollow component designs.

Completed parts were sent for inspection and testing in the northeast corner of the building and in Building 883. Non-destructive testing used radiography to detect internal flaws in fabricated parts. Radiography was conducted in Rooms 255 and 276.

Fabricated enriched uranium components were sent to Buildings 991, 777, or 707, (depending on the time frame) for final trigger assembly.

Recovery

Enriched uranium recovery operations, conducted in Building 881 from 1952 through 1964, were initiated shortly after fabrication operations began. Several different recovery operations were used, depending on the type of initial material. Enriched uranium recovery processed relatively pure materials and solutions and solid residues with relatively low uranium content.
Uranium recovery involved both slow and fast processes. The slow process involved placing relatively impure materials with low concentrations of uranium into nitric acid for leaching and solvent extraction. Impure materials such as slag, sand, crucibles from foundry operations, and residues from the incinerator were reduced via the slow process. The materials were crushed into pea-sized feed in a rod mill and placed in dissolving tanks containing nitric acid. Solutions from the dissolution filters were concentrated in tall (three-story high) solvent extraction columns that originated in a pit in the basement. The solution was then pumped into various evaporators for further processing.

The fast process handled materials that were relatively pure, including uranyl nitrate, and used conversion and reduction steps to produce a pure uranium button (conversion steps changed the physical or chemical nature of the compound; reduction steps changed the compound from a higher to a lower oxidation state). Materials such as chips from machining operations, and black skull oxide from the foundry operations contained fairly high percentages of enriched uranium that were easy to convert into pure uranium buttons. Chips and skull oxides were burned to form uranium oxide and then transferred for dissolution in small batches of concentrated nitric acid. The dissolution room housed three rows of controlled hoods known as B-boxes (similar to lab hoods). These boxes operated with high air velocities at their openings to ensure that the vapors were contained within the hood.

The dissolution process yielded a uranyl nitrate solution, from which a uranium peroxide was precipitated. Once filtered, the precipitate formed a yellow, cake-like substance that was heated (calcined) to produce an orange uranium oxide. The dissolution, precipitation, and calcination processes were originally performed as batch processes. By the late 1950s to early 1960s, the processes became one continuous operation. The orange oxides were converted to uranium tetrafluoride, a green salt. The conversion was conducted by placing the orange oxides into monel (copper-nickel alloy) containers, heating to reduce the compound, and adding anhydrous hydrogen fluoride. The green salts were transferred to a sealed metal bomb reactor for final reduction to uranium metal. Building 881 operations initially produced enriched uranium buttons approximately 3 kg in size; however, with process improvements, these operations were able to produce buttons up to 15 kg in size.

Other recovery operations included incineration of combustible residues, reprocessing enriched uranium from site returns (weapons returned to the Plant for upgrade, reprocessing or retirement), briquetting of relatively pure enriched uranium scraps, and recovery of enriched uranium fines from oil coolant systems.

Uranium-contaminated combustible materials such as wipes, cheesecloth used to clean up minor drips, wood, cardboard, and air filters were incinerated in 3'-diameter incinerators located in Room 233. White ash generated by the incinerator was sent to the slow recovery process side to recover enriched uranium.

Beginning sometime after 1960 and continuing until 1977, Building 881 housed the chemical recovery operations for site returns and rejected enriched uranium weapon components. The first step was to remove surface plutonium contamination by bathing the returned parts in nitric acid. The used acid solution was collected, concentrated by evaporation, calcined to a dry oxide, and sent to Building 771 for recovery of plutonium. The cleaned parts were crushed in a press, processed, and used as feed material for the foundry.

The briquetting process was used to recover scraps of relatively pure enriched uranium from machining operations. The scraps were cleaned in a solvent bath, then pressed into small briquettes to be used as foundry feed material.

Accumulated uranium fines were cleaned out of the machining operations' oil coolant system on a semi-annual basis. After the coolant lines were drained, accumulated fines were flushed from the system using an acid solution. The acid/uranium fine solution was sent through the slow process for recovery of the uranium. Uranium trapped on the oil coolant filters was recovered by incineration.

Special Projects

A number of special projects ranging from ongoing research and development to one-time operations were conducted in Building 881 between 1953 and 1966. These projects included tracer components (processing of neptunium, curium, and cerium), uranium 233 processing, lithium fabrication, recovery of fuel rods, distillation, and cadmium plating of uranium parts.

Stainless Steel Operations (1966-84)

Stainless steel work at the Plant consisted primarily of fabrication of the reservoirs that held tritium gas external to the hydrogen bomb trigger. Other stainless steel work included fabrication of the tubes and fasteners associated with the tritium reservoir-to-trigger delivery system, and the sealing of beryllium ingots into stainless steel containers as part of the beryllium wrought process. Stainless steel work was transferred from Building 881 to Building 460 between 1983 and 1985.

Feed material for stainless steel operations was received at the Plant as bar stock purchased from an off-site vendor. Stainless steel casting, forging, or recovery operations were not conducted on a production scale at the Plant.

Production operations included machining, cleaning, assembling, inspection and testing, and support. Depending on technical requirements, methods, and/or equipment needed, the sequence of operations was altered to meet specific project needs.

Stainless steel parts associated with the tritium delivery system were machined in Rooms 244, 245, and 296. Conventional tools, such as lathes, mills, borers, and presses were used in machining operations. After machining, fabricated parts were cleaned using solvents, acids, and aqueous detergents. Equipment associated with the cleaning process included two vapor degreasers, and an ultrasonic cleaning unit. After machining and cleaning, the parts were inspected and tested.

Inspection and testing operations included dimensional inspection (precise measurements), non-destructive testing, and destructive testing of representative samples. As part of non-destructive testing, parts were visually inspected for flaws and x-rayed to identify internal structural flaws.

Assembly operations were conducted in Building 881, although final assembly of some components was conducted in Building 707. Assembly operations included matching, brazing, and welding. The parts were physically matched together, then assembled and joined by brazing or welding (tungsten-inert gas, electron-beam, or resistance). Welding machines were maintained in vacuum chambers.

Other assembly operations consisted of clinching pressure fittings, tube bending, wire winding, solid film applications, fixture assembly, vacuum bakeout, resin molding, and adhesive assembly.

Stainless steel operations in Building 881 were incorporated into the beryllium wrought process in October 1967. Beryllium ingots (cast in Building 444) were transferred to Building 881 to be enclosed in stainless steel. This was done to aid in subsequent beryllium rolling and forming processes that occurred in Building 883.

Recent Operations (Post-1984)
After stainless steel manufacturing was moved out of Building 881, the building became a multi-purpose facility for research and development, computer support, analytical support, and administrative functions. Building 881 housed the Plant's central computing facilities and the general chemistry laboratory. The laboratory provided general analytical and standards calibration, as well as development operations including waste technology development and development and testing of mechanical systems for weapons systems.

After the Plant's mission changed to environmental remediation in 1989, a reduced amount of research and development continued in Building 881. The laboratories are intact, but idle.

The final use of the building was to house approximately forty organizations. These included production, production support, research, and administrative functions. Administrative operations involved operation of the computer center, development of computer systems, and management and storage of Plant records.

Sources: Colorado Department of Health. *Project Tasks 3 & 4 Final Draft Report. Reconstruction of Historical Rocky Flats Operations and Identification of Release Points (1992),* by ChemRisk. Rocky Flats Repository. Golden, Colorado.

United States Department of Energy. *Historical Release Report (HRR) (1994),* by EG&G. Rocky Flats Plant Repository. Golden, Colorado, 1994.

Padron, Henry, employed at the Plant by the site contractor since 1969. Personal communication, December 1997.

United States Department of Energy. *Final Cultural Resources Survey Report (1995),* by Science Applications International Corporation. Rocky Flats Repository. Golden, Colorado, 1995.